LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI

Electric Potential
&
Capacitance

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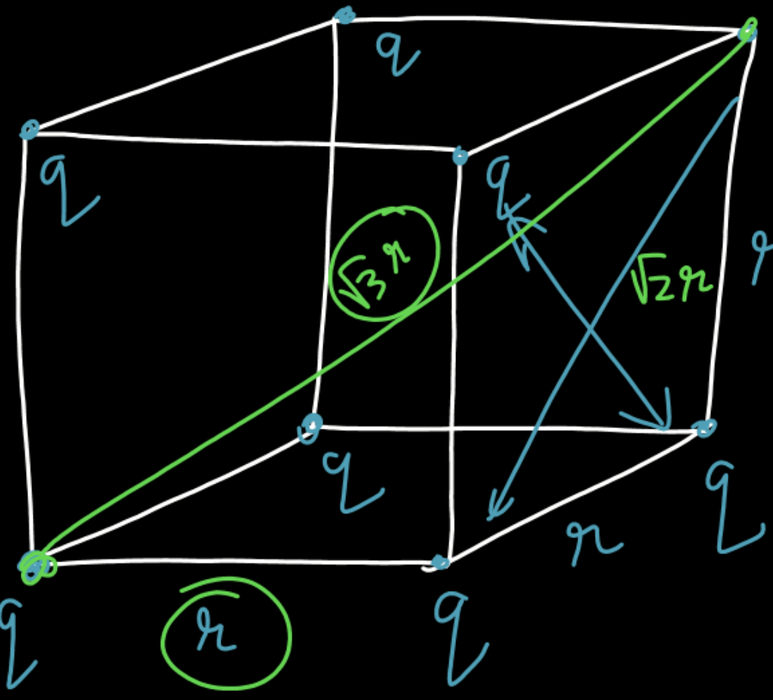
Today's GOALS!

- Electrostatic potential energy
- Relation between potential and potential energy
- Self energy



edge :- 12

Faces? = 6

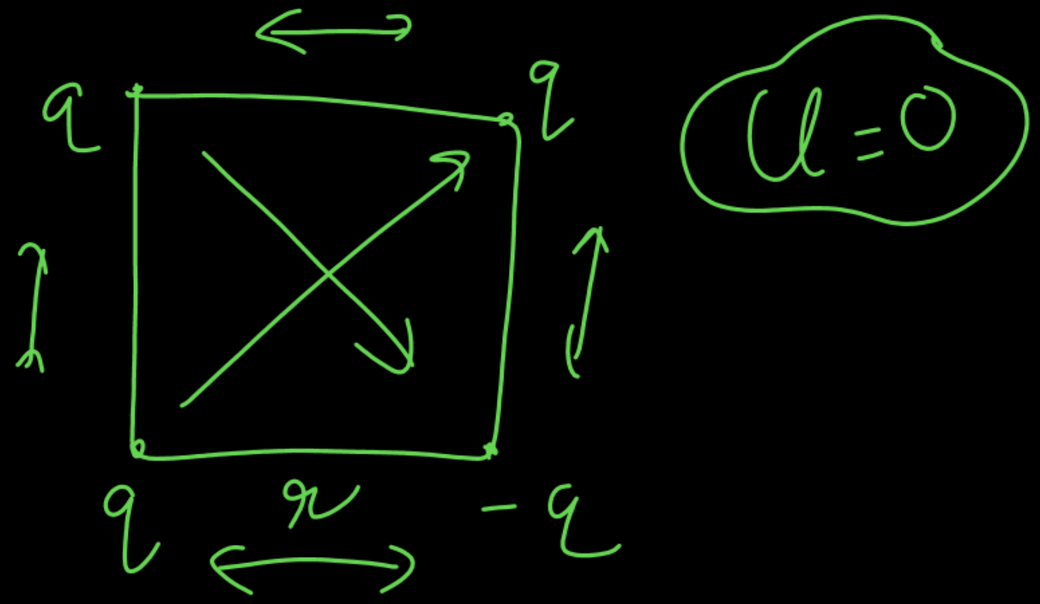
face Diagonal = 12

Body diagonal = 4

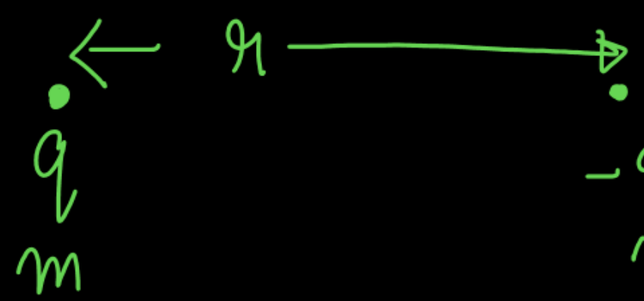
Total pairs = 28.

$$U = 12 \times \frac{kq^2}{r} + 12 \times \frac{kq^2}{\sqrt{2}r} + 4 \times \frac{kq^2}{\sqrt{3}r}$$

$$U = 4\frac{kq^2}{r}\left(3 + \frac{3}{\sqrt{2}} + \frac{1}{\sqrt{3}}\right)$$

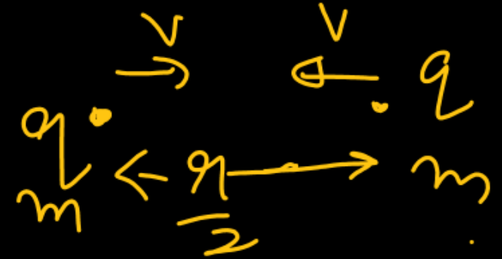

q
q
q
-q
r
U = 0

Q



$$U = \frac{Kq_1q_2}{r}$$

Find the speeds of the charge particles when the distance between them reduces to $r/2$.



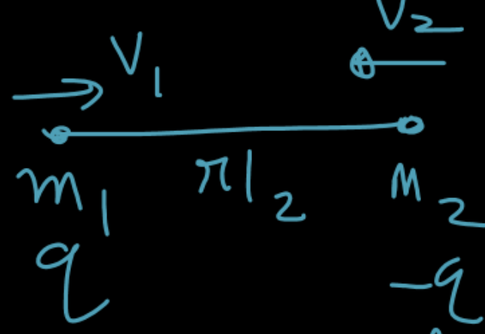
$$KE_i + U_i = KE_f + U_f$$

$$0 - \frac{Kq^2}{r} = 2\left[\frac{1}{2}mv^2\right] - \frac{Kq^2}{\left(\frac{r}{2}\right)}$$

$$\frac{Kq^2}{r}(2-1) = mv^2$$

$$v = \sqrt{\frac{Kq^2}{mr}}$$

Find speed of m_1 when distance b/w charges become $r/2$.



Energy conservation.

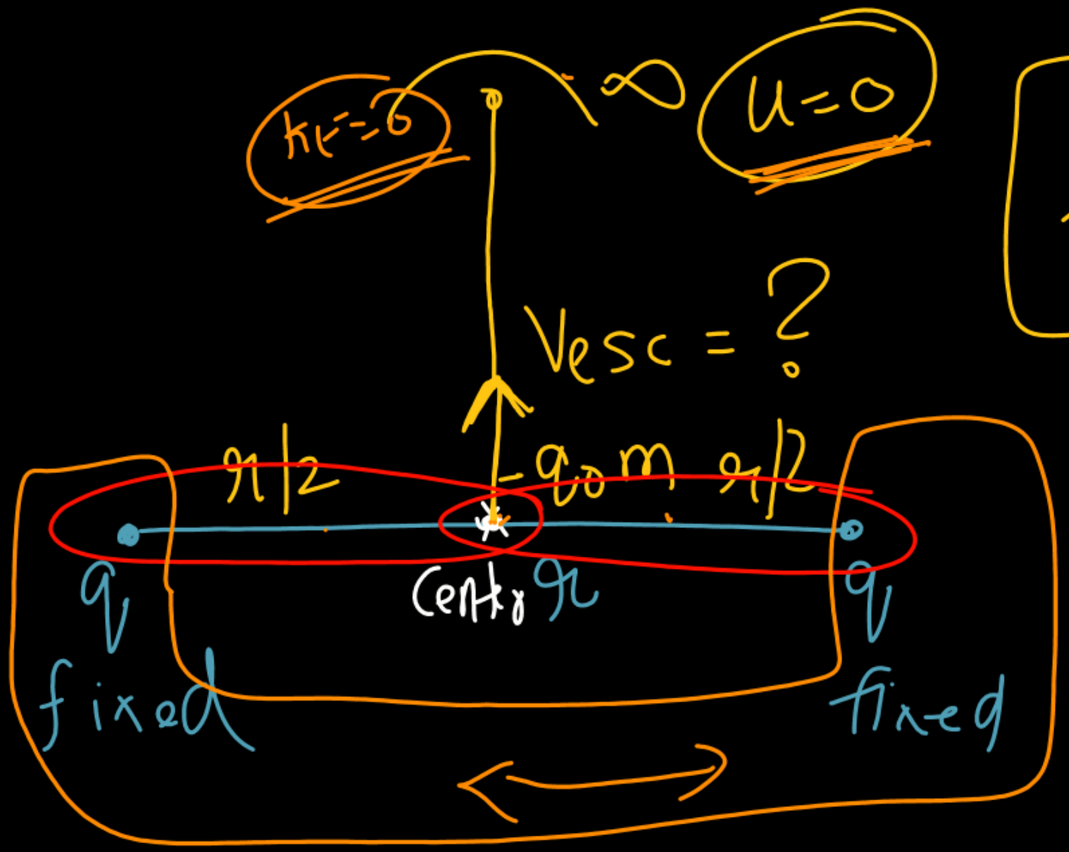
$$U_i + KE_i = U_f + KE_f$$

$$\frac{-kq^2}{r} + 0 = \frac{-kq^2}{\frac{r}{2}} + \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 \quad (1)$$

Momentum Conservation

$$0 = m_1v_1 - m_2v_2$$

$$m_1v_1 = m_2v_2$$



find Vesc ?

T.E. = 0

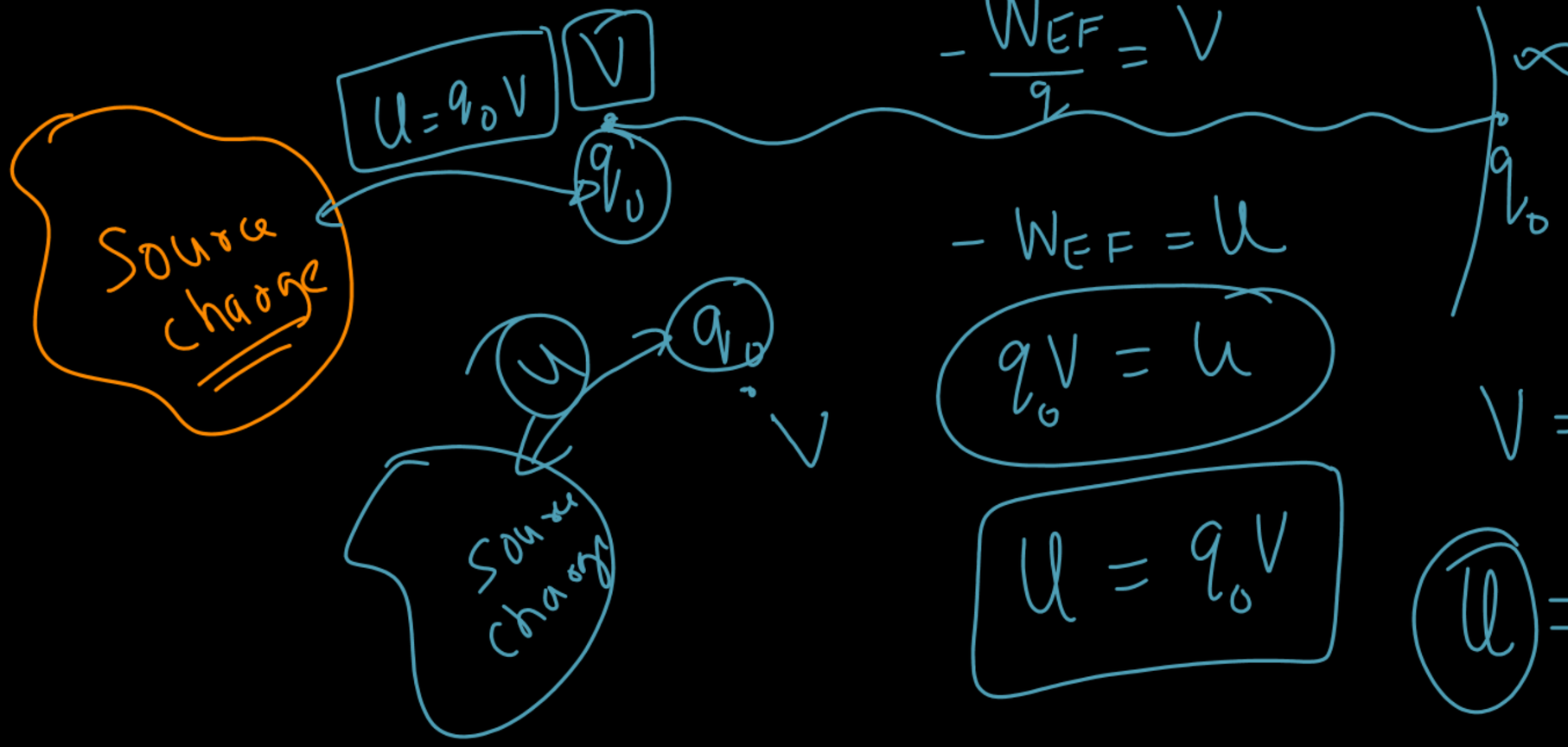
Siddhi

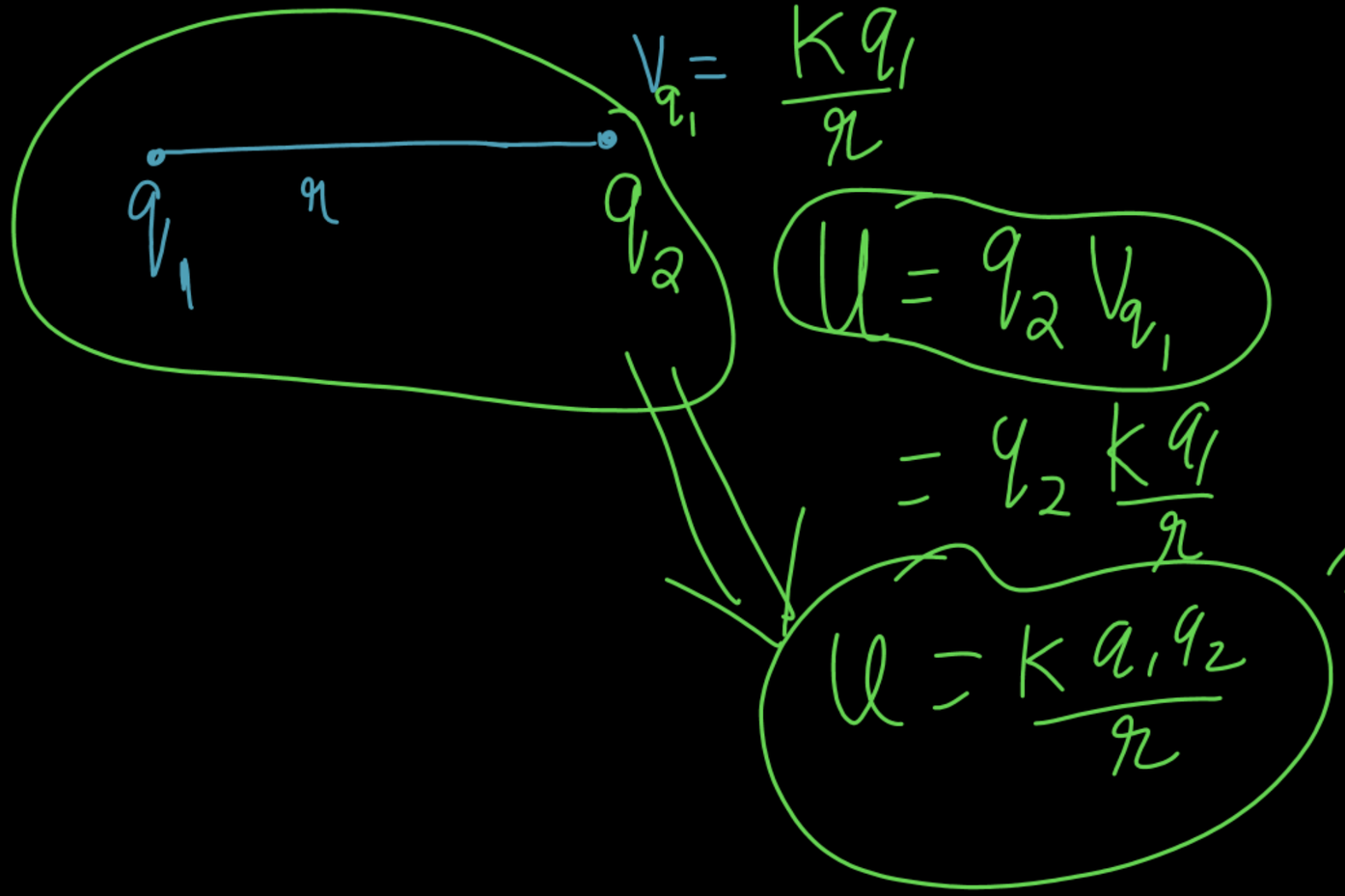
$$\frac{1}{2} m V_{esc}^2 - \frac{K q q_0}{\frac{r}{2}} \times 2 = 0$$

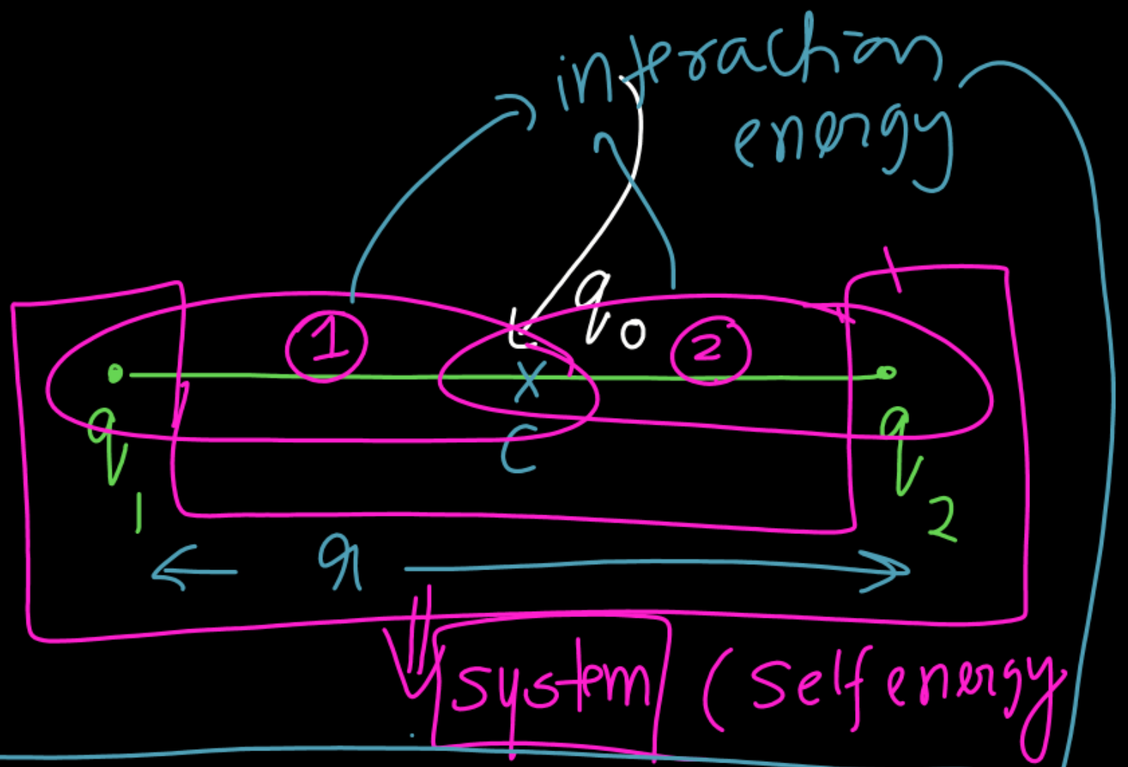
$$\frac{1}{2} m V_{esc}^2 = \frac{4 K q q_0}{r}$$

$$V_{esc} = \sqrt{\frac{8 K q q_0}{m r}}$$

Relation between Potential Energy and Potential




$V_{q_1} = \frac{kq_1}{r}$
q_1
r
q_2
$U = q_2 V_{q_1}$
$= q_2 \frac{kq_1}{r}$
$U = \frac{kq_1q_2}{r}$
⇒ interaction Potential energy



$$V_{Cq_1q_2} = \frac{Kq_1}{\frac{r}{2}} + \frac{Kq_2}{\frac{r}{2}}$$

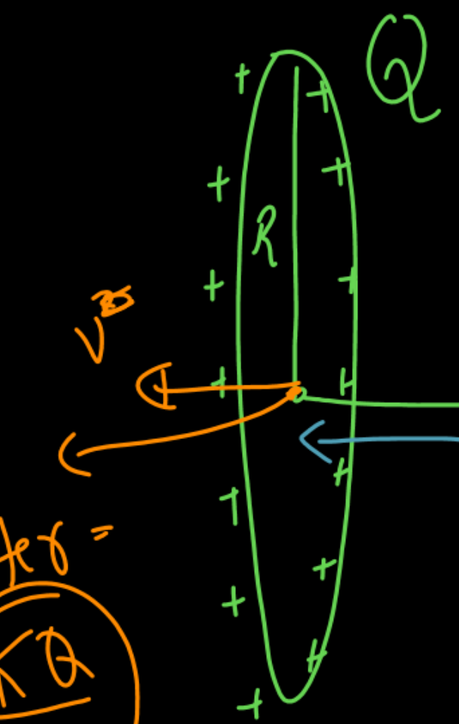
$$= \frac{2K}{r}(q_1+q_2).$$

Total energy = self energy + Interaction energy

$$U = q_0 V$$

$$U = q_0 \times \frac{2K}{r}(q_1+q_2).$$

$$= \frac{2K}{r}(q_0 q_1 + q_0 q_2)$$



Find the speed of 'q' when it reaches the center of the ring?

rest
$-q, m$

$\sqrt{3}R$

$V_{center} = \frac{KQ}{R}$

$KE_i + U_i = KE_f + U$

$0 - \frac{KQq}{2R} = \frac{1}{2}mv^2 - \frac{KQq}{R}$

$\frac{KQq}{R}\left(1 - \frac{1}{2}\right) = \frac{1}{2}mv^2$

$v = \sqrt{\frac{KQq}{mR}}$

$V = \frac{KQ}{\sqrt{R^2+x^2}} = \frac{KQ}{\sqrt{R^2+(\sqrt{3}R)^2}}$

$= \frac{KQ}{\sqrt{R^2+3R^2}} = \frac{KQ}{2R}$

$W_{ext\,agent} = \Delta U$

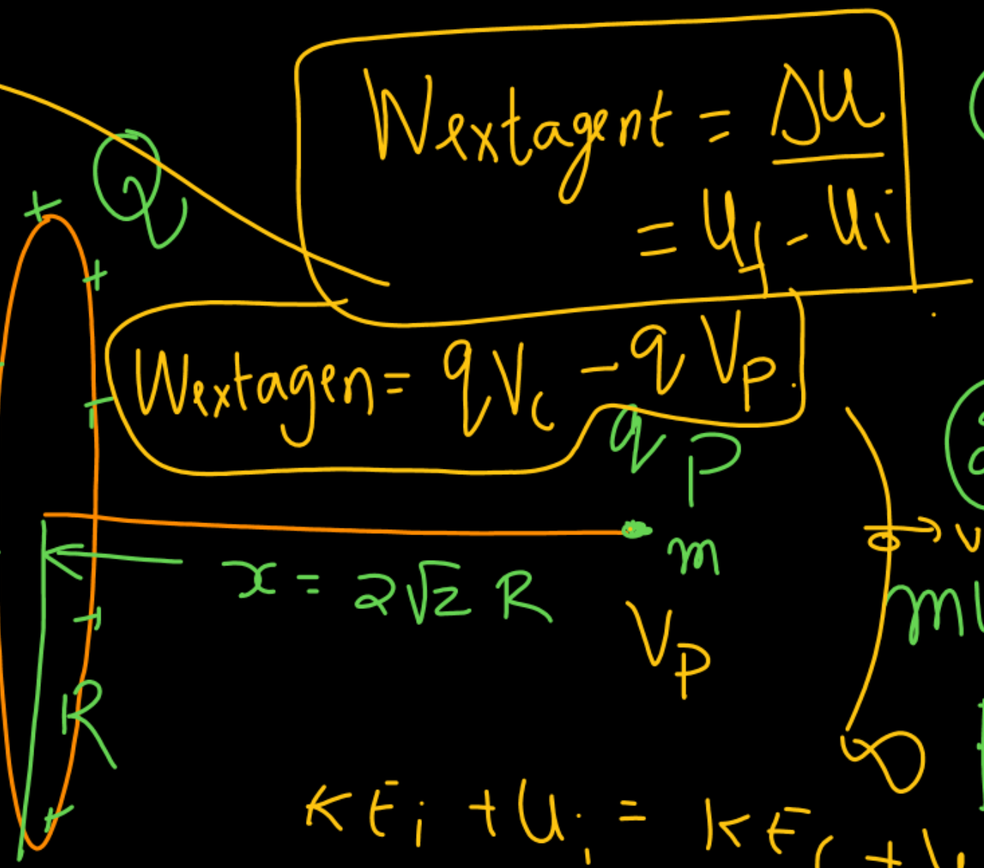
$= U_f - U_i$

$W_{ext\,agen} = qV_c - qV_p$

$V_c = \frac{KQ}{R}$

$V_p = \frac{KQ}{\sqrt{R^2 + (2\sqrt{2}R)^2}}$

$V_p = \frac{KQ}{3R}$



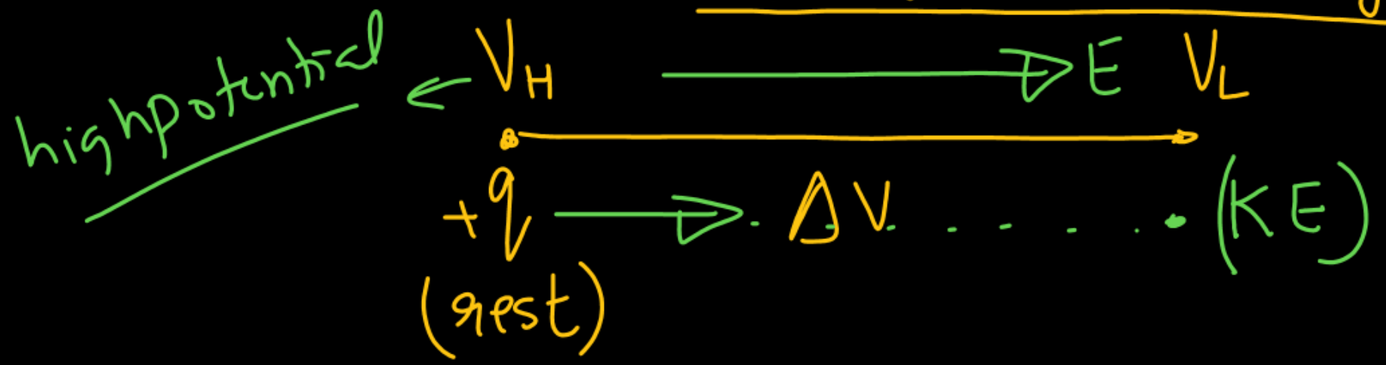
① If m is released what will be its speed at ∞?

② Find how much work must be done to take 'm' from point P to the center of ring?

$KE_i + U_i = KE_f + U_f$

$0 + q\frac{KQ}{\sqrt{R^2 + (2\sqrt{2}R)^2}} = \frac{1}{2}mv^2 + 0$

Work done on charge



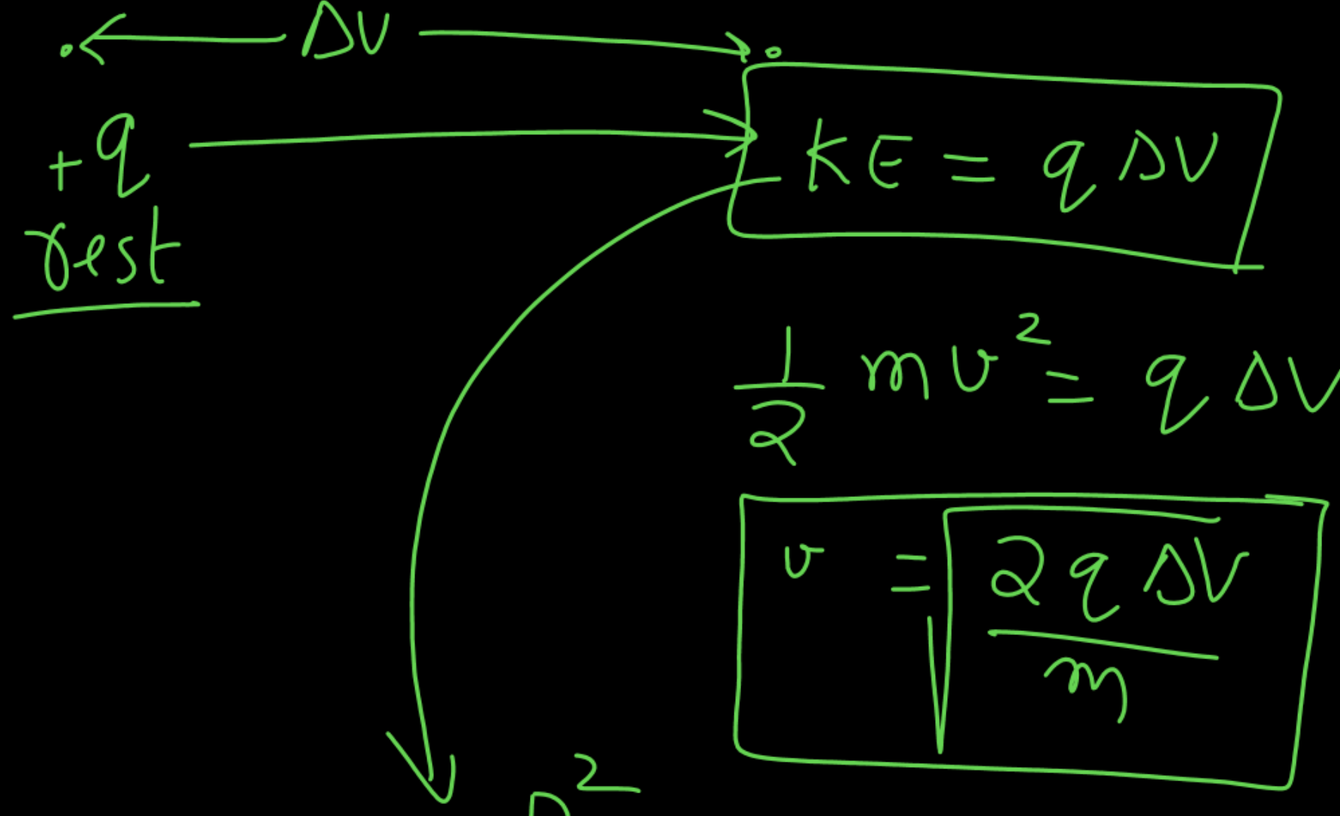
Field ki dir. me potential ghatata hai.

$KE_{gain} = U_{loss}$.

$$\Delta U = q\,\Delta V = \Delta KE$$

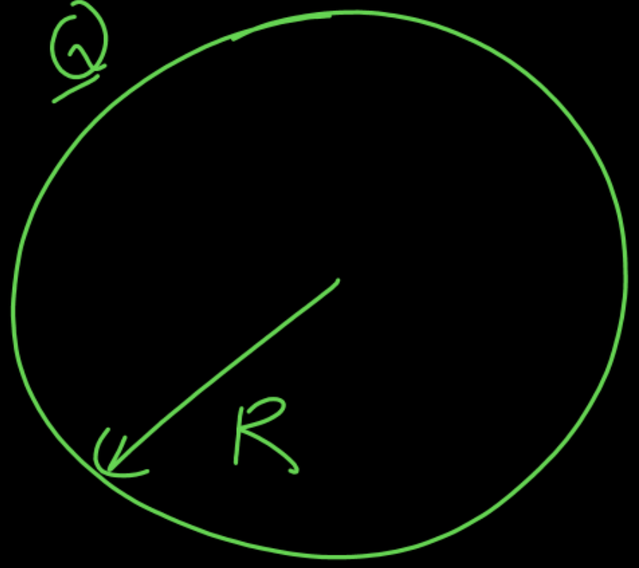
$$\Delta V = \frac{W}{q} = \frac{\Delta KE}{q}$$

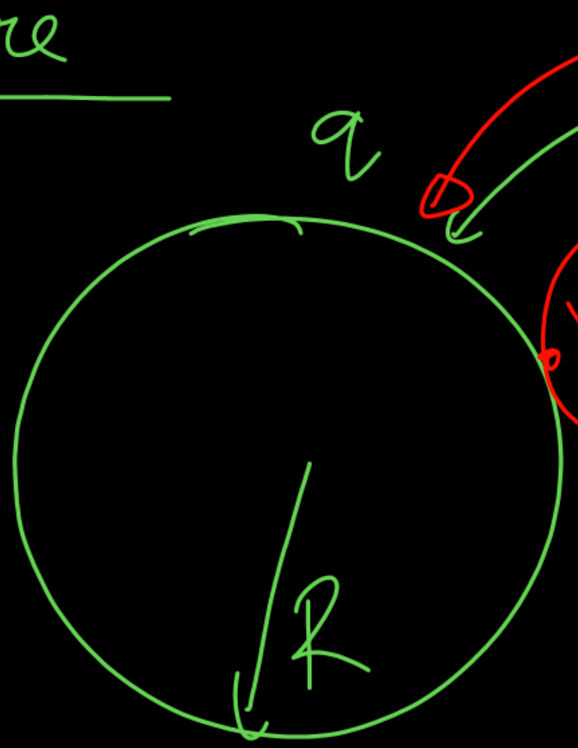
$$\boxed{\Delta KE = q\,\Delta V}$$


ΔV
+q
rest
KE = qΔV
$\frac{1}{2}mv^2 = q\Delta V$
$v = \sqrt{\frac{2q\Delta V}{m}}$
$\frac{p^2}{2m} = q\Delta V$
$p = \sqrt{2mq\Delta V}$

Self Energy

Hollow sphere





$$V = \frac{Kq}{R}$$

$$dU = \frac{Kq}{R}\,dq$$

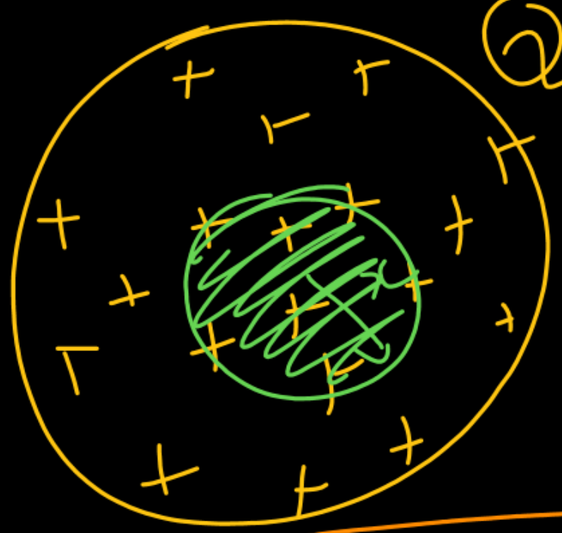
$$\int_0^Q dU = \int_0^Q \frac{Kq}{R}\,dq$$

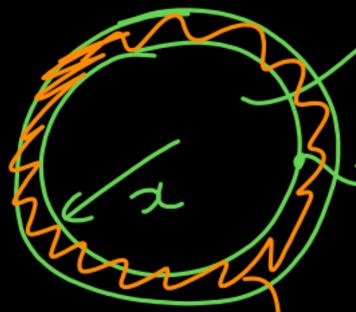
$$U = \frac{K}{R}\,\frac{q^2}{2}\Big|_0^Q$$

$$= \frac{K}{2R}\,Q^2$$

$$U = \frac{KQ^2}{2R} \quad *.$$

Solid sphere





$$q = \frac{Q}{\frac{4}{3}\pi R^3} \times \frac{4}{3}\pi x^3 = \frac{Q x^3}{R^3}$$

$$V = \frac{Kq}{x}$$

$$dq = \frac{Q}{\frac{4}{3}\pi R^3} \times 4\pi x^2\,dx$$

$$dU = \frac{K\left(Q\frac{x^3}{R^3}\right)}{x} \times \frac{Q}{R^3}\,3x^3\,dx$$

$$\frac{3KQ^2}{R^5}\int_0^R x^4\,dx$$

$$U = \frac{3}{5}\frac{KQ^2}{R}$$

Thank You Lakshyians